Original Article

Prediction and Detection of Forest Fires based on Deep Learning Approach

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Abstract

Forest fires are one of the crucial disrupting impact parts inside the overall forest climate, and it causes various levels of adverse consequences on the natural climate, resources, human prosperity, economy, etc.. Climatic changes impact are a few of the results of such pulverization. Generally, forest fires happen due to human exercises. In order to control the annihilation caused by forest fires, we try to identify forest fires at their beginning so that it does not spread. In this paper we have proposed a method, using image processing module and grey scaling for detecting of forest fires using deep learning based algorithms, CNN. After the fire is being detected, an alert is sent to control team of the forest along with location. We have also integrated Google's Firebase for sending alerts through notifications of mobile or iot devices. This paper principally engaged concerning brief prologue to the backwoods fire, related work about different strategies and frameworks in timberland fires, conversation on computerized reasoning and AI calculations and followed by forecast and location frameworks are audited.

Indexed Terms: Forest fires, CNN, Prediction, Detection, Deep Learning.

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INTRODUCTION

Recent years, deforestation and environmental change have caused expanding number of backwoods fires [1]. Forest fires are one of the significant normal concerns, consistently countless hectares are devastated over the world, really hurting similarly as living spirits. Along these lines, foreseeing such a natural issue turns into a basic worry to alleviate this danger [2].

Woods region covers are the defenders of earth's environmental equilibrium. Tragically, the fire is resolved ordinarily once it's as of now contact an outsized space, making its administration and stoppage burdensome and surprisingly unrealistic from time to time. The outcome's staggering misfortune and hopeless damage to the environmental factors and air (30% of carbon dioxide (CO2) inside the climate comes from timberland fires), furthermore to unsalvageable mischief to the biology (colossal measures of smoke and carbon dioxide (CO2) inside the air). Among various awful results of woods fires unit of estimation semi-long-lasting portentous impacts like effects on local climate examples, warming, and eradication of intriguing types of the verdure. Quick and compelling recognition likely could be a key for firefighting.

In Supervised learning, "a director is existed to give experiences to the learning calculation on how a choice or an activity is awful or great". In directed learning, the whole the instructive assortment is stamped absolutely [4]. In independent learning, the instructive assortment is not checked. This drives that the estimation ought to portray the imprints. The plan of the enlightening assortment and the association between the features will be learned by the estimation. Unaided estimations are as k-infers gathering and Self-Organizing Map (SOM). In help learning, the learning estimation gets rebuked assuming there ought to emerge an event of a misguided movement and is remunerated in case of right action [5].

Section 2 fully describe about different survey on forest fire. Section 3 explain about artificial intelligence and different machine learning algorithms. Section 4 focused about fire behavior and detection. And finally section 5 discussed about conclusion of our work.

RELATED WORKS

Forest fire recognition has been a focal point of numerous specialists for the last ten years in view of expanded backwoods fire case reports from everywhere the world because of serious harm to society and the climate.

Huge reasons for woods fire are human-based and nature-

based. Human-based woodland fires are Torching (human-made fire), Smoking and tossing cigarettes, Flashes in electrical cables, hazardous or fire use during hunting, outing fires, shepherd fires, stubble consuming. Nature-based timberland fires are lightning strikes because of high ecological temperature, and so forth Main considerations for the woods fires incorporate Climate factors (Temperature and relative dampness, precipitation wind speed, precipitation, striking likelihood of lighting), Time factors (Christmas season, month, time), populace based elements (populace thickness, human exercises in the timberland, human practices), Scene factors (Tree types, slant, distance from agrarian land, and so forth) and Human-made elements (Short out on power framework lines going through the woodland) [6].

Udaya Dampage et.al. [7] introduced the concept to detect the Forest fire using wireless sensor networks and machine learning. Alonso et al. [8] presented a clever framework for backwoods fire hazard forecast in light of a multi-facet perceptron network [9] – [11]. Raj Vikram [12] utilized SVM and semipositive clear programming displaying to choose the ideal bit capacity of the help vector machine to build up a SVM model for woodland fire expectation. Ditipriya Sinha [13] utilized five different SC innovations, for example, the SVM calculation to anticipate areas of fire cooperations lastly resolved that the SVM calculations could give precise expectations.

Artificial Intelligence (AI) and Deep Learning (DL)

Artificial Intelligence can be characterized as a bunch of techniques that "distinguish designs in information, utilize the uncovered examples to foresee future information or different results of interest". AI itself should be visible as a part of artificial intelligence or insights, depending who you ask, that spotlights on building prescient, distinct, or significant models for a given issue by utilizing gathered information, or approaching information, explicit to that issue. AI techniques advance straightforwardly from information and forgo the requirement for an enormous number of master rules or the need to show individual natural factors with wonderful exactness. AI calculations foster their own inward model of the hidden circulations when gaining from information and in this way need not be unequivocally furnished with actual properties of various boundaries. For instance, in the assignment of demonstrating timberland fire spread, the significant actual properties incorporate fuel structure, nearby climate, and geography. The present status of-the-craftsmanship technique in woods fire forecast incorporates material science based test systems that firemen and key organizers depend on to take numerous basic choices in regards to assignment of scant putting out fires assets in case of a rapidly spreading fire [8]. These material science based test systems, in any case, have specific basic limits: they typically render exceptionally low exactnesses, have a forecast inclination in areas where they are intended to be utilized, and are regularly difficult to plan and execute because of the prerequisite of an enormous number of master rules. Moreover, demonstrating numerous complex natural factors is regularly troublesome because of huge asset prerequisites and complicated or heterogeneous information designs.

AI calculations, be that as it may, gain their own mappings between parametric principles straightforwardly from the information and don't need master rules, which is especially invaluable when the quantity of boundaries is very huge and their actual properties are very perplexing, as on account of woods fire. In this manner, a ML way to deal with woodland fire reaction might assist with keeping away from a large number of the impediments of physical science based test systems [14].

In the former years, Deep Learning [4] has evidenced to be a very significant tool because of its capability to handle great capacities of data. The significance to use hidden layers has surpassed old-style techniques, especially in pattern recognition. One of the most popular deep neural networks is Convolutional Neural Networks (CNN).

CNN is a Deep Learning algorithm which can yield in an input image, assign reputation (like learnable weights and biases) to various features/things in the image and be capable to discriminate one from the other. The pre-processing essential in a CNN is greatly lesser as matched to additional classification algorithms. While in simple methods filters are hand-engineered, with adequate training, CNNs have the capacity to acquire these filters/features.

Fire Behavior and Detection

Fire climate is a basic component in deciding, “if a fire will begin, how quick it will spread, and where it will spread”. Climate perceptions might be interjected from these guide areas toward a matrix over the space of interest, which might incorporate different geographical conditions; the introduction task is a relapse issue. Climate perceptions may accordingly be utilized in the estimation of meteorologically based fire risk lists, for example, the Canadian Fire Climate File (FWI) Framework. Future fire climate conditions and peril files are usually conjecture utilizing the result from mathematical climate expectation (NWP) models.

Recognizing fierce blazes straightaway after they have touched off, and in this manner while they are still somewhat little, is basic to working with a fast and viable reaction.

Peng Wul. [15] utilized ANNs and IR picture dealing with (in blend in with visual symbolism and meteorological and geographic information utilized in a choice breaking point utilizing padded thinking) to see ensured wild flares. A few analysts have correspondingly utilized ANNs for fire discovery. Likewise, Adab H. [16] “utilized ANNs on remote sensor organizations to fabricate a fire discovery framework where multicriteria recognition was utilized on

different characteristics (e.g., fire, hotness, light, and radiation) to identify and raise cautions". Other ML techniques "utilized in fire discovery frameworks incorporate SVM to consequently recognize fierce blazes from videoframes, GA for multi-objective improvement of a LiDAR-based fire location framework, BN in a dream based early fire recognition framework" [13].

Convolutional Neural Organizations (CNN) (i.e., profound learning) [2], which can extricate highlights and examples from spatial pictures and are observing far and wide use in object recognition errands, have as of "late been applied to the issue of fire identification". A few of these "applications prepared the models on earthly based pictures of fire as well as smoke" [15]-[18].

The *figure 1* describe about the flow of fire behavior prediction and detection.

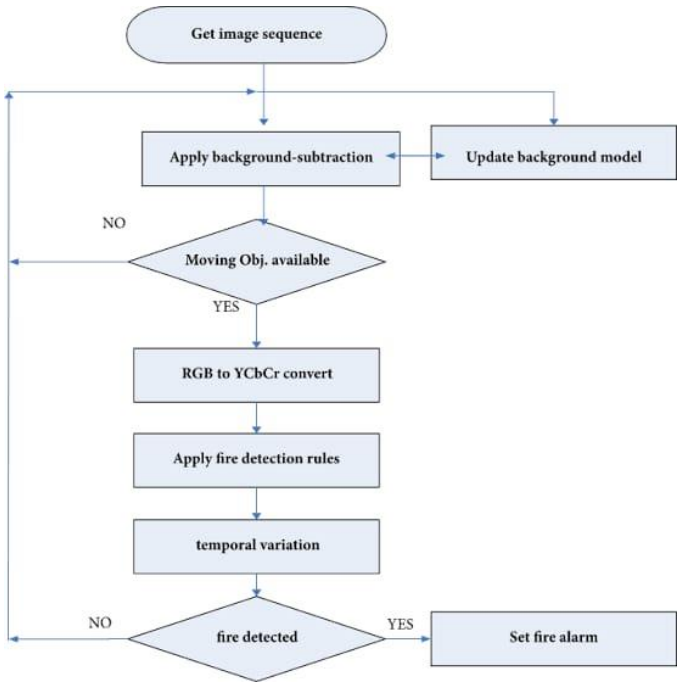


Fig. 1. Flow diagram for Fire behavior prediction and detection

ALGORITHM FOR FOREST FIRE DETECTION

In this proposed method. A custom dataset is prepared with all wild fire images, then separating the gathered images of fire and non-fire forest and training both the fire and non-fire pictures independently, later the picture is grouped depending on the fire signatures. The input pictures are splitted into outlines, the pictorial data is again splitted into pixels with the assistance of CNN BiLSTM which is a hybrid bidirectional algorithm using both LSTM and CNN in combination, this uses a convolution and a max pooling layer to extract a new feature vector from the data pool i.e from the image for calculating the data from the fire observation in the image i.e input data. The BiLSTM is designed to extract features such as smoke and flames from the image i.e the input, by spatial feature recognition using forward and backward order. The attention network i.e CNN is used to optimize the classification process to generate a quick response. Later the processed data using firebase for web and android integration is used to send an alert message to the smart devices of the fire fighters in the shortest time frame.

The forest fire detection algorithm consist of the following modules: fire image creation, fire detection and live fire detection.

The general steps for fire image detection algorithm is as follows:

Create window
Get video properties
Read video frame from file, and handle up to end of file
Re-size image to network input size and perform prediction
output = model.predict([small_frame])
Label image based on prediction
Build network as per following architecture
If (training) then network = regression(network, optimizer='momentum', loss='categorical_crossentropy', learning_rate=0.001)
Construct the final model using the following function
model = tflearn.DNN(network, checkpoint_path='firenet', max_checkpoints=1, tensorboard_verbose=2)
Construct and display model using the following functions
model = construct_firenet (224, 224, training=False)
print("Constructed FireNet...")
model.load(os.path.join("models", "firenet"),weights_only=True)
print("Loaded CNN network weights...")
Image display and key handling

EXPERIMENTAL RESULTS

In this paper, we show the simulations that demonstrate the outcomes of the CNN algorithm and investigate the performance of the algorithm in several situations. In this work, we used UCI datasets for forest fires [19].

For data set import, we have to use the following the commands,

```
df = pd.read_csv('dataset.csv')
df.head(10)
```

For data preprocessing, we used the following statement,

In train set split, data is randomly splitted into training data and testing data. We splitted 80% of training data and 20% of testing data.

```
df['size_category'] = np.where(df['area']>6, '1', '0')
df['size_category']= pd.to_numeric(df['size_category'])
df.tail(10)
```

For train set split, we used the following syntax,

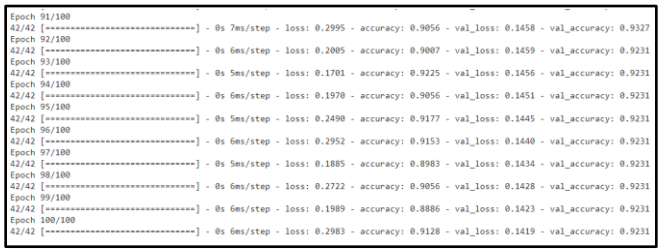
```
features = df.drop(['size_category'], axis = 1)
labels = df['size_category'].values.reshape(-1, 1)


X_train, X_test, y_train, y_test = train_test_split(features,labels,
test_size = 0.2, random_state = 42)
```

The next we are going to compile CNN algorithm with different hyperparameter like epoch (neural network training time), batch size, loss function, activation function and learning rate.

For checking the performance of the methods, we calculated the accuracy measure,

Based on the results of the above experiment, which used the hyperparameter of the base model, the accuracy score of the train data is 96% and the accuracy score of the valid or the test data is 92%.



The *figure 2* shows the accuracy curves. The main parameter is epoch 100 and batch size 10. Based on the output of the accuracy graph, the model begins to show the stability at epochs 60 to 100.

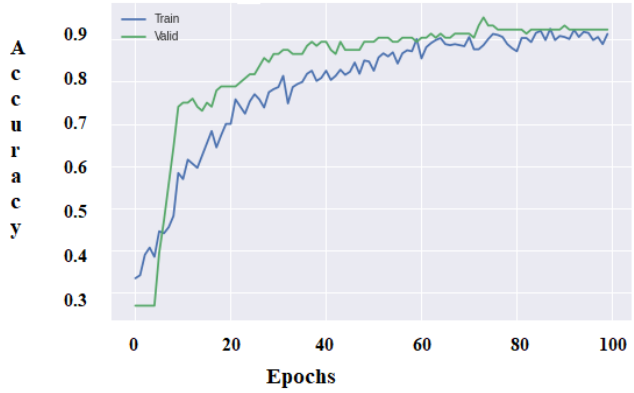


Fig.2. Accuracy curve

The *figure 3* shows the accuracy curves. The main parameter is epoch 200 and batch size 10. Based on the output of the accuracy graph, the model begins to show the stability at epochs 100 to 200.

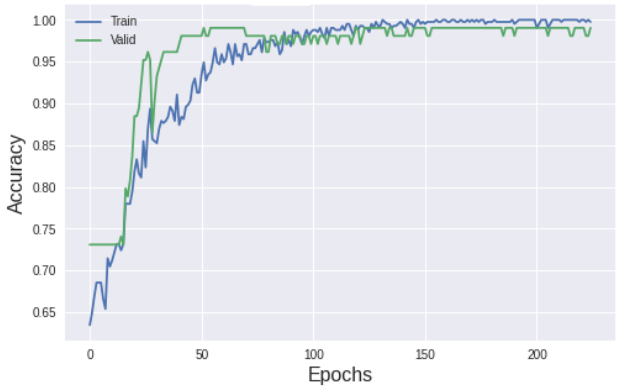


Fig.3. Accuracy curve

The different set of images were given as input in the *figure 3*.

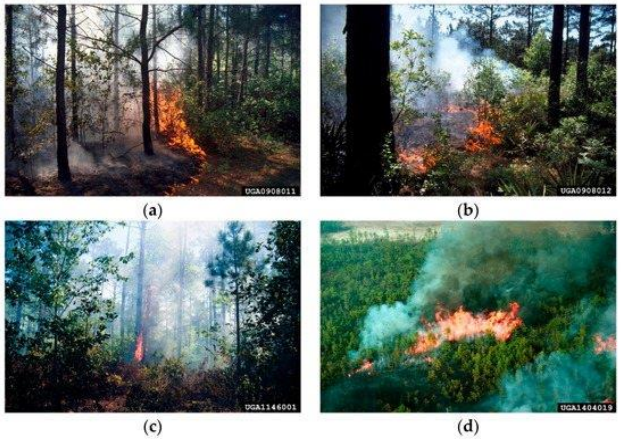


Fig. 3. Input sets

The *figure 3* shows that forest fires are identified and detected using CNN algorithm and it is displayed.

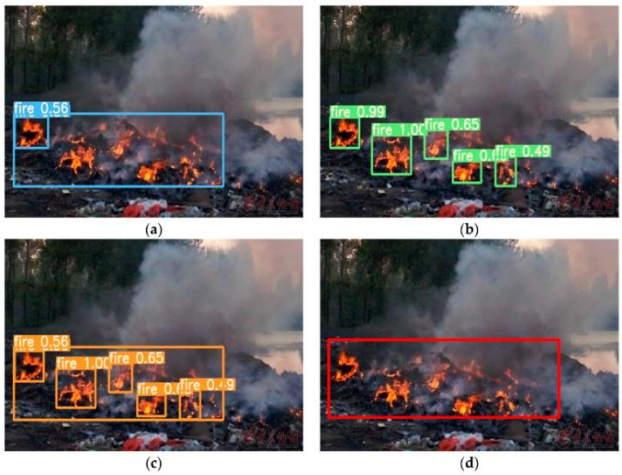


Fig. 3. Forest fire detection using CNN algorithm

```
Confusion matrix :
 [[2 2]
 [1 5]]
Outcome values :
 2 2 1 5
Classification report :
              precision    recall  f1-score   support

           1       0.67      0.50      0.57         4
           0       0.71      0.83      0.77         6

    accuracy                           0.70        10
   macro avg       0.69      0.67      0.67        10
weighted avg       0.70      0.70      0.69        10
```

Fig.4. Confusion matrix

The *figure 4* shows the confusion metrics, accuracy,, F1 score, recall values and it displays the results from the input dataset.

CONCLUSION

In this proposed method, the combination of CNN BiLSTM which is a hybrid bidirectional algorithm using both LSTM and CNN is used in conjunction with the fire base for the portrayal of the cutting edge utilization of deep learning methods, to create a quick response against the fire. It gave a rundown of Deep learning ways to deal with wood fire issues. The BiLSTM is designed to extract features from the image i.e the input by spatial feature recognition using forward and backward order. The attention network i.e CNN is used to optimize the classification process to generate a quick response. It additionally gave an arrangement of these methodologies as per the area of use and Deep Learning strategy with Fire Base to create an optimal solution against the forest fire.

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